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Towards accurate assessments of CH4 and N2O soil-atmosphere exchange rates with the combination of automated systems and new detection techniques

E. Díaz-Pinés, B. Wolf, R. Kiese, and K. Butterbach-Bahl

Institute of Atmospheric and Meteorological Research, Atmospheric Environmental Research (IMK-IFU), Atmosphere/Biosphere Interactions and Global Change, Garmisch-Partenkirchen, Germany (eugenio.diaz-pines@imk.fzk.de)

Soils can be either a source or a sink of CH_4 and N_2O. Accurate assessment of CH_4 and N_2O soil-atmosphere exchange processes is necessary in order to estimate the contribution of soil to the global warming potential under current and future conditions. Soil-atmosphere exchange processes of both CH_4 and N_2O depend on a combination of soil temperature and soil moisture status, as well as on nutrient availability and various microbial processes. The task of measuring CH_4 and N_2O exchange processes is challenging due to, among other factors: high spatial ("hot spots") and temporal heterogeneity ("hot moments") in the emissions of these species. In addition, accurate determination of CH_4 and N_2O concentrations is still difficult. So far, this prevents from a full understanding and contributes to a high uncertainty degree in the assessment of CH_4 and N_2O soil-atmosphere exchange rates across different ecosystems.

Aiming at the achievement of a deeper understanding of the role of the soil in the GHG balance, we have combined new laser spectroscopy detection techniques (Quantum Cascade Laser, QCL) with automatic and semi-automatic chamber measurement systems. Therefore, different applications will be presented:

- A three-month-long field campaign in a poplar plantation in NE Romania allowed us to demonstrate the feasibility of the QCL coupled with automatic chambers to accurately estimate the soil-atmosphere GHG exchange at a high time resolution with a very low detection limit.
- A new semi-automatic system with relatively low human-maintenance requirements was tested in a poplar plantation in SW Germany. The system is not able to record fine-scale temporal variations of the GHG exchange processes; however, cumulative fluxes obtained with the semi-automatic system were very close to those measured with an automatic system with high temporal resolution.
- Within a climate change experiment in grassland ecosystems, an application of the QCL in combination with a robotized chamber for GHG exchange measurements in lysimeters was used.

Special encourage will be given to implementation issues and future improvements of these applications. A comprehensive view of the advantages and limitations of the coupling of QCL devices with automatic measurement systems will be presented, in order to show the potential contribution of these techniques to the accurate assessment of soil-atmosphere GHG-exchange rates.